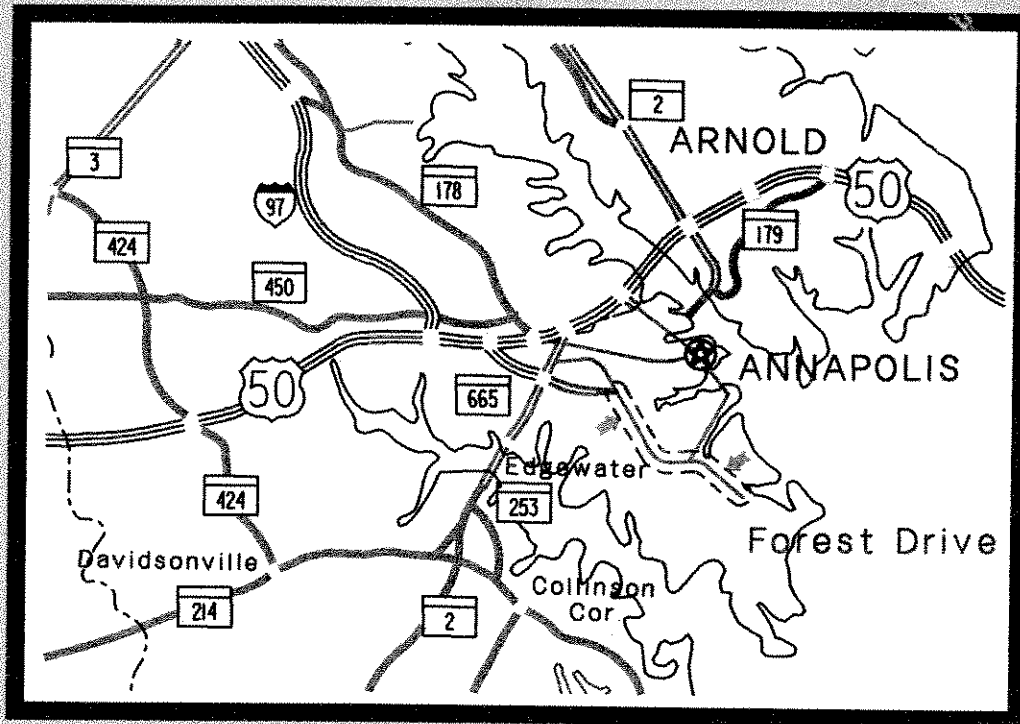


Forest Drive Transportation Study



August 1996

Submitted to:
City of Annapolis
Planning and Zoning Department
160 Duke of Gloucester Street
Annapolis, Maryland 21401



Forest Drive Transportation Study
The City of Annapolis, Maryland

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I. FOREST DRIVE TRANSPORTATION STUDY

A. INTRODUCTION

The Annapolis Neck Peninsula encompasses a diversity of residential subdivisions, commercial development, employment centers, and recreational open space. Traffic generated by the various land uses creates an unacceptable mix of heavy, simultaneous inbound and outbound traffic. In an effort to maintain the quality of life and economic vitality of the Annapolis Neck, it is critical that an adequate transportation network is provided.

Based on this philosophy, the City of Annapolis Department of Planning and Zoning has employed Whitney, Bailey, Cox & Magnani to conduct a comprehensive analysis of the primary access route serving the peninsula, Forest Drive.

The study encompasses four elements. The first component is a comprehensive inventory of the study corridor, including the following elements:

- ▶ Traffic Volume Inventory
- ▶ Roadway/Intersection Inventories
- ▶ Accident Experience
- ▶ Existing Intersection Operations
- ▶ Existing Roadway/Intersection Operations
- ▶ Existing Transit Service

The second element involves a determination of design year 2010 traffic volumes, based on regional traffic growth and site specific development along Forest Drive. The regional traffic increases included two scenarios, a high and low growth component with a reassessment of traffic operations at key roadway segments/intersections along the corridor with the projected design year 2010 traffic volumes. Roadway improvements necessary to accommodate the design year traffic were also identified.

The third component is an origin-destination study.

The fourth element of the study is a feasibility study associated with providing an alternate route for Forest Drive.





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B. EXISTING CONDITIONS

1. Traffic-Volume Inventory

Peak period (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.) turning movement count data was collected at the following key intersections in the study area:

- ▶ Forest Drive at Chinquapin Round Road
- ▶ Forest Drive at Hilltop Lane
- ▶ Forest Drive at Spa Road
- ▶ Forest Drive at Hillsmere Drive/Bay Ridge Road
- ▶ Bay Ridge Road at Edgewood Road
- ▶ Bay Ridge Road at Arundel on the Bay Road

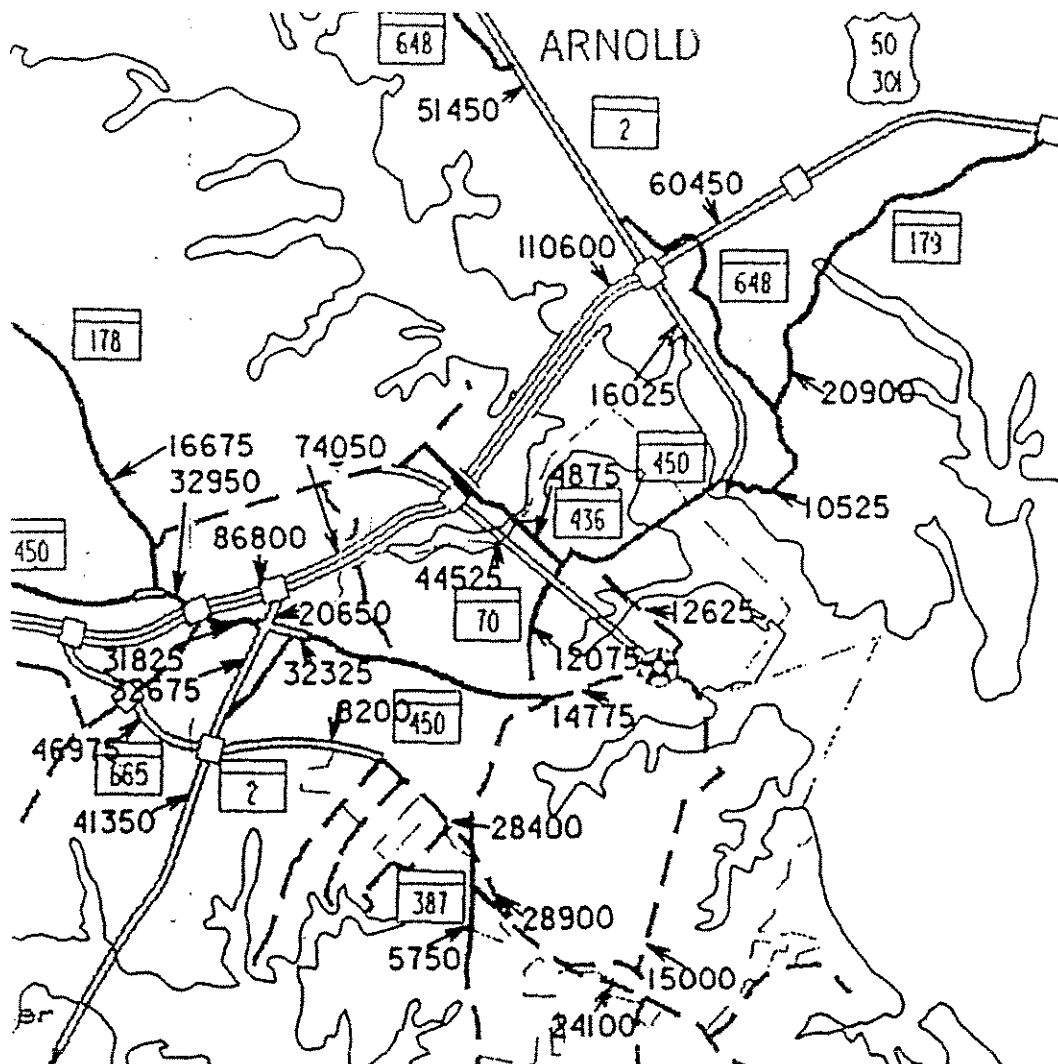
The count data is provided in Appendix A. In addition to the peak period count data, hourly 24-hour count data, and Average Daily Traffic (ADT) volume figures were secured. The 24-hour count data collected by Anne Arundel County is provided in Appendix A and was used to confirm the peak periods for the turning movement counts. The ADT volumes were developed by the Maryland State Highway Administration (SHA) through permanent count stations and historic traffic trends along Forest Drive. The 1994 ADT volumes for the Annapolis area, including Forest Drive, are shown below in Figure 1:





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FIGURE 1
1994 AVERAGE DAILY VOLUMES
FOREST DRIVE





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2. Roadway/Intersection Inventories

Roadway Inventory: The basic section of Forest Drive, from South River Road to Dominoe Road, provides one through lane in each direction. Between Dominoe Road and Chinquapin Round Road a three lane section has been constructed. East of Chinquapin Round Road to South Cherry Grove Road, Forest Drive transitions to a five lane section. Four lanes are present between South Cherry Grove Road and Gemini Drive. The section from Gemini Drive to Arundel on the Bay Road has been, or is scheduled to be, improved to a five lane section with landscaped medians between Forest Hills Avenue and Hillsmere Drive. The current lane geometry is summarized in Table 1.

TABLE 1
FOREST DRIVE ROADWAY INVENTORY
MD 2 TO BYWATER ROAD

ROW	Pass Zone	Section	Roadway Width/Ft.	# Lanes	Edge Treatment		Median
					North	South	
90'	N/A	MD 2 to South River Rd.	48	4	Conc. Curb	Conc. Curb	4' Conc.
70' ±	N	South River Rd. to W of Link St.	48	4	Conc. Curb	Conc. Curb	DY
30' ±	N	W of Link St. to Parole St.	24 ¹	2	3'-8' shldr	8'-10' shldr	DY
30' ±	N	Parole St. to E of Dominoe Rd.	24 ¹	2	3' shldr	8' shldr	DY
50' ±	N	E of Dominoe Rd. to Fairfax Rd.	48	3 ²	Disc. Conc. Curb w/12' shoulder	Bit. Curb	DY
50' ±	N	Fairfax Rd./Forest to Chinquapin Round Rd.	38	3 ²	Conc. Curb	Conc. Curb	DY
100' ±	N/A	Chinquapin Round Rd./Fairfax to Forest	Var.	6-8	Conc. Curb	Conc. Curb	Planted raised
VAR	N/A	Chinquapin Round Rd. to Louis Drive	84	6	Conc. Curb	Conc. Curb	Planted raised
165' ±	N/A	Louis Drive to Bywater Rd.	84	7	Conc. Curb	Conc. Curb	LT



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FOREST DRIVE ROADWAY INVENTORY
BYWATER ROAD TO ARUNDEL ON THE BAY ROAD

ROW	Pass Zone	Section	Roadway Width/Ft.	# Lanes	Edge Treatment		Median
					North	South	
160'	N/A	Bywater Rd. to S. Cherry Grove Rd.	60	5	Disc. Conc. Curb	Conc. Curb	LT
55'	N	S. Cherry Grove Rd. to Hilltop Lane	48	4	4' ± grav shldr	Disc. Conc. and Bit. Curb	DY
55' to 80'	N/A	Hilltop Lane to Spa Road	48	4	Bit. Curb	Disc. Bit. Curb	DY
120'	N	Spa Road to Gemini Drive	48	4	Bit. Curb	Conc. Curb	DY
80' to 120'	N/A	Gemini Drive to Youngs Farm Road	60	5	Conc. Curb	Conc. Curb	LT
50' to 80'	N	Youngs Farm Rd. to Tyler Ave	48	4	Conc. Curb	Conc. Curb	DY
75'	N	Tyler Ave to Forest Hills Ave	60	5	Conc. Curb	Conc. Curb	LT
125' to 155'	N	Forest Hills Ave to E of Forest Hills Ave	60	4	Conc. Curb	Conc. Curb	Planted raised
115'	N	E of Forest Hills Ave to Thom Drive	60	5	Conc. Curb	Conc. Curb	LT
85'	N	Thom Drive to W of Hillsmere Drive	60	4	Conc. Curb	Conc. Curb	Planted raised
80'	N	W of Hillsmere Dr. to Arundel on the Bay Road	60	5	Conc. Curb	Conc. Curb	LT

- (1) Actual roadway width varies considerably due to variable shoulder widths; travelway width is 24 ft.
- (2) Two lanes eastbound, one lane westbound.

Abbreviations: Grav. Shldr. - Gravel Shoulder; Disc. Curb - Discontinuous Curb; Bit. Curb - Bituminous Curb; LT - Left Turn Lanes; DY - Double Yellow Line; Conc. Curb - Concrete Curb.

Several roadway projects are planned for the corridor in the near future. The County will be completing the five lane section along Forest Drive from Youngs



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Farm Road to Tyler Avenue. The Maryland State Highway Administration will be constructing improvements to Forest Drive in the near future from Bywater Road to link with the County's improvements at Gemini Drive providing a five lane section with double left turn lanes at Hilltop Lane. Two developers will be constructing improvements to Bywater Road and Spa Road to provide additional turn lanes. The improvements from Bywater Road to Spa Road are summarized in Figure 2.

Travel Speeds: A review of travel speeds along the corridor was included as part of the inventory. Two posted speed limits are present along Forest Drive/Bay Ridge Road, 30 MPH in the west from South River Road to Chinguapin Round Road and 40 MPH from Chinguapin Round Road to Arundel on the Bay Road. Off peak 85th percentile travel speeds were documented along the corridor using the "floating car" technique. The speeds are assessed by driving with the traffic stream in a given platoon. Based on the floating car readings gathered, average travel speeds are five to 10 MPH above the posted speed limits along all sections of Forest Drive.

Intersection Inventories: In addition to the basic roadway segments, condition diagrams were secured through a research of County/State Highway Administration files of as-built signal plans for the key intersections in the study area illustrating utilities, traffic control devices, traffic signal phasing, lane use, pavement markings, roadway/lane widths, sight distance and topographic features. The condition diagrams are provided in Appendix A.

3. Accident Experience

Four years of accident data (1990 through 1993) were received from Anne Arundel County and the City of Annapolis and are provided in Appendix B. The data includes intersection as well as mid-block accidents. In a macroscopic view, the accident experience for the corridor is summarized below:

Number of Injuries	452
Number of Fatalities	3 (Pedestrians)
Intersection Related	56%
Lighting Condition: Darkness	33%
Pavement Condition: Dry	68%





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The wet weather accidents are comparable to state-wide averages. However, the nighttime accidents are higher than the state-wide average of 28%, indicating improved safety lighting is warranted along the corridor.

Intersection Accidents: A high accident intersection, for the purposes of the inventory, is defined as a location with an accident experience of more than five accidents per year. Accident experience at each intersection along Forest Drive is summarized in Table 2. Due to the major geometric changes at the Forest Drive/Chinquapin Round Road intersection, review of historical accident data for the intersection was not appropriate. Review of the tables indicates several intersections experienced more than five accidents per year. The high accident intersections are as follows:

- ▶ Forest Drive at South River Road
- ▶ Forest Drive at Bywater Road
- ▶ Forest Drive at Newtowne Drive
- ▶ Forest Drive at Hilltop Lane
- ▶ Forest Drive at Spa Road
- ▶ Forest Drive at Gemini Drive
- ▶ Forest Drive at Tyler Avenue
- ▶ Forest Drive at Hillsmere/Bay Ridge

TABLE 2
INTERSECTION ACCIDENT EXPERIENCE
FOREST DRIVE - SOUTH RIVER ROAD TO FAIRFAX ROAD
1990 THROUGH 1993

Intersection	1990	1991	1992	1993
South River Road*	36	21	6	14
Link Street	1	1	0	2
Centre Street	12	3	3	1
Hicks Avenue	1	4	1	2
Dominoe Road	3	1	0	1
Fairfax Road	15	4	5	2





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INTERSECTION ACCIDENT EXPERIENCE
FOREST DRIVE - BYWATER ROAD TO ARUNDEL ON THE BAY ROAD
1990 THROUGH 1993

Intersection	1990	1991	1992	1993
Bywater Road*	23	20	19	22
Greenbriar Lane	0	2	0	1
Annapolis Neck Road	0	1	0	0
S. Cherry Grove Ave.	1	0	1	3
Newtowne Drive*	27	22	19	37
Hilltop Lane*	31	16	27	46
Crystal Spring Farm Road	1	1	1	1
Spa Road*	35	18	28	32
Gemini Drive*	10	14	22	16
Old Forest Drive	0	1	1	0
Rosecrest Drive	3	5	6	5
Tyler Avenue	38	30	19	34
Marda Lane	1	1	0	1
Barbud Lane	1	1	1	2
Crows Nest Court	1	4	1	0
Annapolis Neck Road	0	1	0	0
Forest Hills Avenue	6	2	5	4
Thom Drive	1	3	0	1
Hillsmere Drive*	12	5	11	10
Cypress Road	0	0	0	0
Old Annapolis Neck	0	1	0	0





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Intersection	1990	1991	1992	1993
Georgetown Road	0	0	0	2
Edgewood Road	0	0	0	1
Carrolton Road	0	0	0	0
Arundel on the Bay	0	0	0	3

* High accident intersection

Collision diagrams were prepared for each high accident location based on the data supplied by Anne Arundel County and are provided in Appendix C. Collision diagrams illustrate the paths vehicles traveled for each accident and are used to identify predominant accident patterns. The data from the City of Annapolis included the many "fender bender" accidents that occur in the corridor for which accident reports are not written. Therefore, data is not available regarding the collision patterns. However, the collision diagrams represent the more severe accidents which occurred at the key intersections. Although the diagrams do not include all accidents at the intersection, the information provides a valuable tool to define predominant accident patterns.

Based on a review of the sites and collision diagrams, the following assessment was made for each high accident intersection:

South River Road: Roughly half of the accidents involved vehicles turning left from Forest Drive. Mainline left turn lanes are not available at the intersection, thus drivers queued in the through lanes waiting to turn left are accepting insufficient gaps to negotiate a turning movement and exit the through lane. Construction of turn lanes would improve operations; however, construction costs would be quite high with right-of-way acquisitions required. One important point to consider is that the majority of the accidents occurred during the period of higher traffic volumes on Forest Drive, prior to the opening of Aris T. Allen Boulevard. The diversion of traffic to Aris T. Allen Boulevard and subsequent reduction of volumes along Forest Drive should help reduce the conflict potential at the intersection. The SHA high accident intersection list for 1995 should be reviewed, when available, to assess a change in accident experience.





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Bywater Road: Several of the collisions involved vehicles exiting Bywater Road. Improvements currently under construction to provide additional turn lanes should help to mitigate accidents along the minor street approach.

Newtowne Drive: The majority of the accidents related to turning movements to/from Newtowne Drive. A roadway project is planned by the County to link Newtowne Drive with a new access onto Forest Drive opposite South Cherry Grove Road. The existing access on Newtowne Drive will be limited to right-in right-out movements, thus eliminating turning movements across Forest Drive and reducing the accident experience.

Hilltop Lane: The accident experience at Hilltop Lane relates directly to the heavy eastbound left turn volumes and lack of left turn lanes. The roadway improvements planned by the SHA to provide a double left turn lane should significantly reduce the accident frequency at Hilltop Lane.

Spa Road: A definitive accident pattern was not evident. However, the accidents occurring along Forest Drive could be attributed to the mainline congestion and lack of right turn lanes for the heavy turning movements from Forest Drive. The improvements planned by a local developer to construct right turn lanes and additional turn lanes on northbound Spa Road should mitigate accident experience at the intersection.

Gemini Drive: The majority of accidents involved vehicles slowing to enter the commercial driveways on the south side of the intersection being struck by through traffic. A cost effective means of mitigating the accident experience would involve constructing access control along forest Drive to limit the number of driveway entrances.

Tyler Avenue: The predominant accident patterns at Tyler Avenue involve through vehicles colliding on Forest Drive and left turn vehicles from Tyler Avenue impacting through traffic on Forest Drive. In addition, over half of the accidents occurred at night. Mitigation measures would include safety lighting and upgrading of the traffic signal to improve conspicuity. The current signals are old and do not provide sufficient target value for motorists. The County is currently designing a new signal installation for this intersection to address the visibility issue. Also, signal clearance and all-red timings should be reviewed to ensure traffic on Forest Drive has sufficient decision time. The construction of





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a five lane section through the intersection will reduce delays and congestion in the intersection, which, in turn, should reduce the rear-end collisions involving through traffic on Forest Drive.

Hillsmere Drive: No major predominant accident pattern exists at the Hillsmere Drive intersection. The driveways at the intersection are possible contributing factors to the accident experience. In addition, "signal ahead" signing should be considered since the intersection is far removed from other signalized intersections, and, therefore, violates driver expectancies possibly contributing to the accident experience.

Mid-Block Accidents: For analysis purposes, a high accident roadway segment was defined as a location with over ten accidents reported per year for a given roadway segment. The accident data was reviewed and grouped according to representative similar segments as shown in Table 3.

TABLE 3
MID-BLOCK ACCIDENT SUMMARY
FOREST DRIVE

Segment	Accident Experience			
	1990	1991	1992	1993
South River Road to Link Street	11	10	4	2
Link Street to Dominoe Road	8	11	5	2
Dominoe Road to Chinquapin Round Road	20	8	4	3
Chinquapin Round Road to Bywater Road	19	21	15	6
Bywater Road to Newtowne Drive	23	18	12	11
Newtowne Drive to Spa Road	16	10	26	7
Spa Road to Rosecrest Drive	32	25	30	25
Rosecrest Drive to Hillsmere Drive	24	15	16	6
Hillsmere Drive to Georgetown Road	14	3	4	3
Georgetown Road to Arundel on the Bay Road	1	4	2	0



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As indicated, mid-block accidents are more prevalent to the west than in the eastern portion of the corridor. Several factors influence the mid-block accident experience, including higher traffic volumes, lack of access control and lack of left turn lanes. A review of the mid-block accidents revealed only two sections with a noteworthy number of collisions. The sections between Bywater Road and Newtowne Drive, and Spa Road and Rosecrest Drive experienced ten or more non-intersection related accidents per year.

The accident experience along Forest Drive, between Bywater Road and Newtowne Drive, relates to the capacity constraints and delays from closely spaced, adjacent intersections. The proposed consolidation of Greenbriar Lane and Newtowne Drive should improve the safety along the corridor. The collision patterns in the vicinity of Gemini Drive involve vehicles entering/exiting the numerous commercial drives along Forest Drive being hit from behind by through traffic. Access consolidation would significantly improve the accident experience in the corridor between Spa Road and Rosecrest Drive. The proposed five lane section will help to mitigate the accidents involving vehicles stopped to turn left in the travel lanes of Forest Drive.

4. Existing Intersection Operations

The morning and evening peak hours within each peak period count from Appendix A were determined and balanced as appropriate. The resultant counts are illustrated in Figure 3. Intersection operating efficiencies were calculated based on level of service analyses with the balanced counts and existing lane geometry. Level of service (LOS) is a means of quantifying traffic flow conditions by assigning letter grades "A" through "F" to the location studied based on traffic volumes. Level of service "A" is ideal, LOS "D", though not optimal, is considered the minimum range of operations that drivers will accept. Failing operations with unacceptable delays and queuing are indicative of level of service "E" or "F".

A detailed description of operations associated with each letter grade is provided below. Also noted in the level service descriptions are the volume to capacity (V/C) ratios for each letter grade. The V/C ratios provide an additional means of quantifying an intersection's reserve capacity within each letter grade. The ratio is derived by dividing the intersection critical lane volume by the maximum number of vehicles the intersection can accommodate (capacity), which, for the





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study, will be taken as the minimum Level of Service "D" volume of 1,450 vehicles.

Level-of-Service A describes operations with very low delay, i.e., less than 5.0 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Volume to capacity ratios up to 0.68

Level-of-Service B describes operations with delay in the range of 5.1 to 15.0 seconds per vehicle. This generally occurs with good progression. More vehicles stop than for LOS A, causing higher levels of average delay. Volume to capacity ratios of 0.69 to 0.79.

Level-of-Service C describes operations with delay in the range of 15.1 to 25.0 seconds per vehicle. These higher delays may result from "fair" progression. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping. Volume to capacity ratios of 0.80 to 0.90.

Level-of-Service D describes operations with delay in the range of 25.1 to 40.0 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable. Volume to capacity ratios of 0.91 to 1.00.

Level-of-Service E describes operations with delay in the range of 40.1 to 60.0 sec per vehicle. These high delay values generally indicate "poor" progression. Individual cycle failures are frequent occurrences. Volume to capacity ratios 1.00 to 1.10.

Level-of-Service F describes operations with delay in excess of 60.0 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition occurs when arrival flow rates exceed the capacity of the intersection. Volume to capacity ratios in excess of 1.10.

Results of the analyses are summarized in Table 4 and Figure 3. The computation sheets are illustrated in Appendix C.





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TABLE 4
LEVEL OF SERVICE SUMMARY
FOREST DRIVE - EXISTING CONDITIONS

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road	D	C
Bywater Road	D	F
Hilltop Lane	F	F
Spa Road	E	D
Hillsmere Drive	C	C
Edgewood Road	A	A
Arundel on the Bay	A	A

As indicated in the table, operational difficulties exist in the western portion of Forest Drive between Bywater Road and Spa Road. The lack of turn lanes on the minor streets and along Forest Drive accounts for the poor levels of service. Currently, plans are underway to construct improvements to the intersections of Bywater Road, Hilltop Lane and Spa Road as noted previously. The improvements are being constructed by the Maryland State Highway Administration and private developers as illustrated in Figure 2. The capacity analyses were recomputed with the improved geometry as currently proposed and are summarized in Table 5. The computation sheets are in Appendix C.





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TABLE 5
LEVEL OF SERVICE SUMMARY
EXISTING CONDITIONS
FOREST DRIVE - IMPROVED GEOMETRY

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road	D	C
Bywater Road (1)	D	E
Hilltop Lane (2)	F	B
Spa Road	D	C
Hillsmere Drive	C	C
Edgewood Road	A	A
Arundel on the Bay	A	A

- (1) LOS D - A.M. and C - P.M. with additional through lane eastbound
- (2) LOS D - A.M. and A - P.M. with additional through lane westbound

As noted in the table, even with the roadway improvements as currently programmed, the intersections of Forest Drive with Bywater Road and Hilltop Lane will continue to function at an unacceptable level of service. The heavy eastbound through movement at Bywater and the high volume of westbound left turn traffic at Hilltop Lane are the catalysts for the additional improvements. Figure 4 illustrates the current levels of service and volume to capacity ratios with required lane geometry to provide acceptable levels of service along the corridor.

5. Existing Roadway Segment Operations

The operating efficiency of mid-block roadway segments is based on a free-flow condition. Signalized intersections interrupt continuous flow and govern the operational assessment of a roadway. Along the Forest Drive Corridor, the close proximity of adjacent signalized intersections between Chinquapin Round Road and Spa Road make roadway segment analysis inappropriate. However, such





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analyses can be performed for Forest Drive between Link Road and Dominoe Road in the western portion of the corridor, Tyler Avenue to Hillsmere Drive, Hillsmere Drive to Edgewood Road, and Edgewood Road to Arundel on the Bay Road to the east. The analyses were conducted using the 1995 Highway Capacity Manual Technique developed by the Transportation Research Board. The analysis procedures take into account the number of travel lanes, passing zones, and traffic volumes in determining levels of service. The computations are provided in Appendix C, and a summary of the existing operating conditions is provided in Table 6.

TABLE 6
LEVEL OF SERVICE SUMMARY
EXISTING CONDITIONS
FOREST DRIVE - MID BLOCK SEGMENTS

Forest Drive To/From	A.M. Peak Hour		P.M. Peak Hour	
	EB	WB	EB	WB
Link Road to/from Dominoe Road	A	A	A	A
Tyler Avenue to/from Hillsmere Drive	A	A	B	A
Hillsmere Drive to/from Edgewood Road	A	A	B	A
Edgewood Road to/from Arundel on the Bay	A	A	A	A

Results of the analyses indicate that reserve capacity is available along the mid-block segments of Forest Drive.

6. Public Transit

Currently, commuters using Forest Drive have one viable means of public transit. Annapolis Transit "Street" Service Route No. 7 has stops on Forest Drive, between Riva Road and Hilltop Lane, and between Spa Road and Tyler Avenue. The route will be modified starting May 4, 1996. The route that will serve most of Forest Drive will be known as the "Brown Route." The Brown Route Schedule has been provided as Figure 5. The route has been expanded to include all of Forest Drive, from Riva Road to Edgewood Road. In addition to the Brown Route, an "Orange Route" will be added, which will leave a circuitous route and serve Bywater Road, Newtowne Drive, Spa Road, and Tyler Avenue.



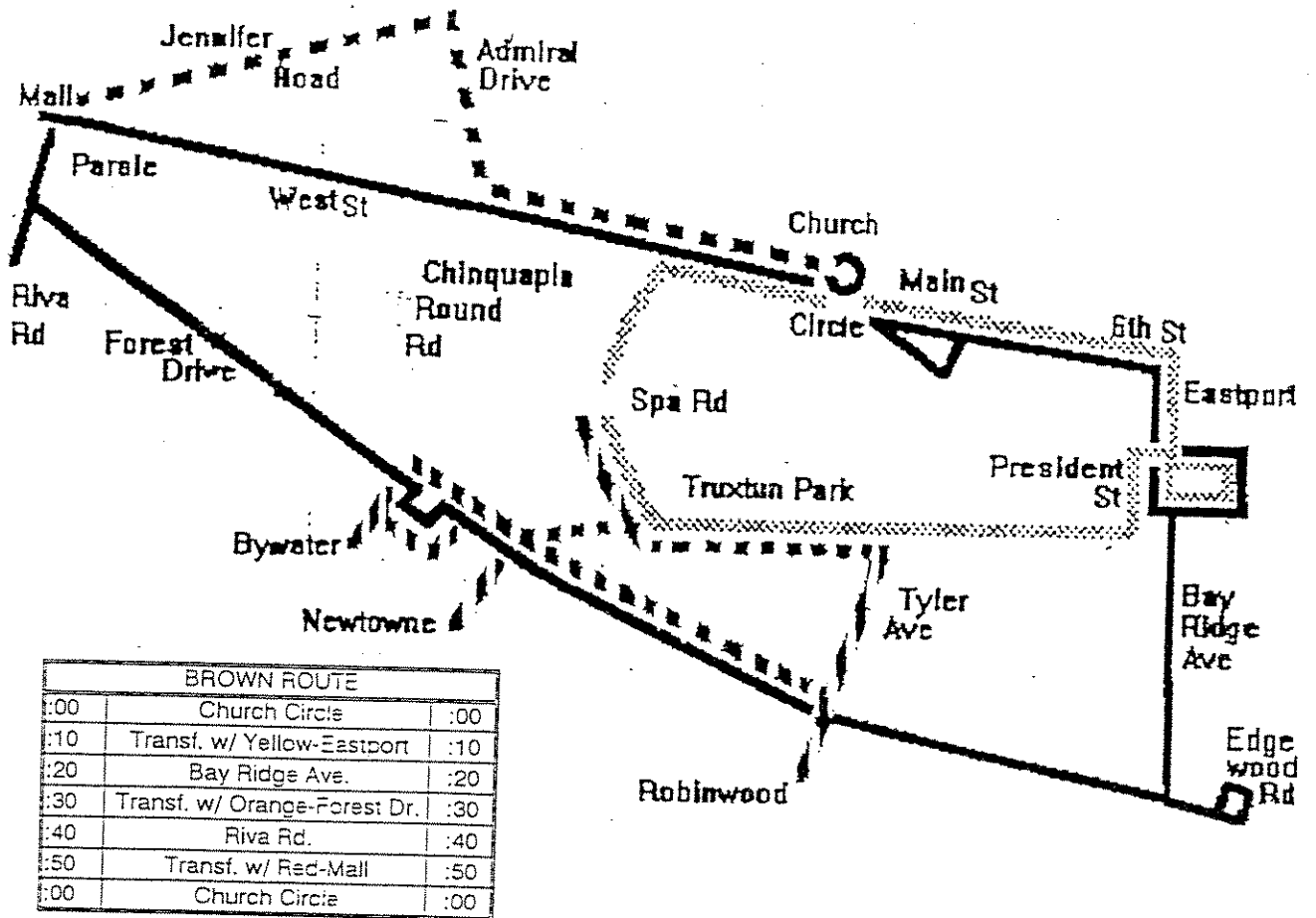


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The expanded routes and additional transfers should make mass transit more attractive to commuters.

FIGURE 5
"BROWN" ROUTE FOREST DRIVE BUS SCHEDULE





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C. DESIGN YEAR 2010 TRAFFIC PROJECTIONS

1. Regional Traffic Growth

Although Forest Drive serves a peninsula, traffic volumes would experience an increase even if no additional development was to occur. The growth in traffic would result from redevelopment of existing land, increased trip generation from development outside the study area, and increased traffic attracted by existing development along Forest Drive from new projects outside the study area.

The regional traffic growth was quantified through a review of historical traffic along Forest Drive. Summarized below in Table 7 are the average daily traffic volumes along Forest Drive, east of Spa Road, as collected by the State Highway Administration.

TABLE 7
AVERAGE DAILY TRAFFIC VOLUMES
FOREST DRIVE, EAST OF SPA ROAD

Year	Volume	Yearly Percent Increase From 1994
1994	28,900	N/A
1992	27,300	2.9
1990	28,000	0.7
1988	26,300	1.6
1986	21,000	4.0
1984	19,000	4.3
1982	21,400	2.5

Based on the data presented above, an annual growth rate of 2.4 percent was selected for the Forest Drive mainline from South River Road to Hillsmere Drive. The 2.4% factor provides for a growth in background traffic, as well as the potential for redevelopment of several of the parcels within the study area to a more trip intensive use. Since the corridor serves a peninsula, a blanket application of the 2.4 percent rate from MD 2 to Arundel on the Bay Road would not be appropriate. East of Hillsmere Drive, Forest Drive (Bay Ridge Road) serves low density residential, with no direct access to the major employment





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centers in Annapolis. Therefore, a nominal one percent growth rate was applied to the mainline and cross street existing peak hour turning movement count data east of Hillsmere Drive. A one percent annual growth rate was used for turning movements to/from each of the key intersecting streets west of Hillsmere Drive, with the exception of Hilltop Lane, Spa Road to/from the north and Bay Ridge Road to/from the north. The 2.4% rate was applied to these routes, as they serve key access corridors entering and exiting the peninsula. The resultant year 2010 background traffic volumes are illustrated in Appendix D. In an effort to assess both high and low growth scenarios, a second analysis was conducted with a one percent growth rate applied to traffic volumes throughout the corridor. Shown in Appendix D is the year 2010 background traffic volumes with high and low growth rates assuming no additional development in the study area.

2. Site Generated Traffic

In an effort to assess a "worst case" scenario for analysis of the year 2010 conditions, an evaluation of development potential along the corridor was prepared. The assessment included currently programmed development and potential build-out of undeveloped land. The remaining balance of currently approved development was secured through a review of City and County records, and field documentation of present occupancy. The additional build-out available in the study area was calculated based on existing zoning, deletion of unbuildable area, and standard development yields for the corridor. The available build-out for the study area with the corresponding trip generations, based on standard Institute of Transportation Engineers (ITE) rates, are summarized in Table 8.

TABLE 8
DEVELOPMENT TRIP GENERATION
SUMMARY

Development	Size	Trips			
		A.M.		P.M.	
		Enter	Exit	Enter	Exit
* Oxford Landing II	82 Townhouses	7	37	35	8
* Annapolis Walk	165 Townhouses	13	63	62	32
* Annapolis Overlook	145 Condominiums	12	58	57	29
* Beechwood Hills	6 Townhouses	1	5	4	2





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Development	Size	Trips			
		A.M.		P.M.	
		Enter	Exit	Enter	Exit
Cherrystone	4 Single Family Units	1	4	4	2
Harbor Drive	5 Single Family Units	2	4	4	3
Assisted Liv. Facility	30 Beds	8	6	6	8
St. Anne's Private School	50-75 Students	85	75	0	0
Steeplegate South	55 Single Family Units	12	36	40	23
Church Creek Farms	7 Single Family Units	2	6	6	4
Steeplegate Sec. 1	90 Single Family Units 325 Townhouses 200 Apartments	65	241	248	135
Rosenweig	34 Single Family Units	8	24	26	15
Riverwalk	21 Single Family Units	5	16	17	9
Ruegg	5 Single Family Units	2	4	4	3
Cherrystone	7 Single Family Units	2	6	6	4
Subtotal	1,151 Dwellings	218	585	519	277

* Approved City Project

DEVELOPMENT TRIP GENERATION
SUMMARY - POTENTIAL DEVELOPMENTS

Planning Area	Max. Size	Trips			
		A.M.		P.M.	
		Enter	Exit	Enter	Exit
A	327 Townhouses/Apts	22	108	109	56
B	129 Single Family Units	26	75	87	49
C	40 Single Family Units	9	27	30	17
Subtotal	496 Dwellings	57	210	226	122
TOTAL DEVELOPMENT TRIPS		275	795	745	399





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Planning Area A is a 32.5-acre parcel of land located between Greenbrier Lane and Newtowne Drive, fronting Forest Drive to the south. It is surrounded by multi-family dwellings and Planning Area B to the southwest.

Planning Area B is an 86.2-acre parcel that borders single family dwelling developments to the south and multi-family developments to the north and east. The MD 665/MD 2 interchange is west of Planning Area B.

Planning Area C is a 20-acre plot of land located south of Forest Drive. The parcel is located between Spa Road and Open View Lane. It is divided into two pieces by existing single-family dwellings. The western portion fronts Harness Creek Road, while the eastern portion is located between Cobblestone Court and Open View Lane.

The trips noted above were distributed to the Forest Drive network based on the existing turning movement count data. The distributed counts are illustrated in Appendix D.

Both the background development scenarios were added to the site-specific trips to generate high and low total design year 2010 peak hour turning movements, and are illustrated in Appendix D.

3. Design Year 2010 Intersection Operations

The intersection operations were reassessed with only the increase due to background traffic, assuming no new development in the study area, and with the total design year 2010 traffic volumes for both the high and low growth scenarios. The intersection geometry used in the assessments included the programmed improvements of the State, County, and area developers. The resultant levels of service for the total traffic volumes with a high growth rate are summarized below in Table 9 and Figure 6. Also illustrated in Figure 6 are the volume to capacity ratios for each intersection. The computation sheets are provided in Appendix D.



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TABLE 9
LEVEL OF SERVICE SUMMARY
DESIGN YEAR 2010 - HIGH GROWTH 2-4%
NO ADDITIONAL DEVELOPMENT
FOREST DRIVE

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road	F	F
Bywater Road	F	F
Hilltop Lane	F	F
Spa Road	F	F
Hillsmere Drive	F	E
Edgewood Road	C	A
Arundel on the Bay	B	A

The levels of service were re-assessed with the total traffic volumes, and are summarized in Table 10 and Figure 7.

TABLE 10
LEVEL OF SERVICE SUMMARY
DESIGN YEAR 2010 - HIGH GROWTH -2-4%
FULL BUILD-OUT
FOREST DRIVE

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road	F/F	F/E
Bywater Road*	F/F	F/E



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Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
Hilltop Lane*	F/F	F/C
Spa Road*	F/C	F/D
Hillsmere Drive*	F/D	E/D
Edgewood Road	C	A
Arundel on the Bay	B	A

* LOS with current proposed geometry/LOS with roadway improvements.

Review of Table 10 and Figure 7 indicates major capacity constraints would exist between Chinquapin Round Road and Spa Road, despite the currently planned improvements. Even with no new development along Forest Drive, improvements would be required to accommodate projected traffic as shown in Table 9 and Figure 7. Volume to capacity ratios were well in excess of 1.00, both with and without the new development along Forest Drive. The Forest Drive/Hillsmere Drive/Bay Ridge Road intersection also would require improvements to accommodate projected traffic volumes. Figure 8 provides summaries of the improvements necessary to bring the intersections to an acceptable level of service. The Hillsmere Drive intersection would require improvements to the northbound and westbound approaches to add an additional lane. Spa Road could also be improved through lane additions to yield an adequate level of service. However, even with maximizing lane additions to an eight lane section, the intersections of Bywater Road and Hilltop Lane would continue to operate at an unacceptable level of service, indicating trip reduction measures or a bypass route would be required to reduce traffic demand and provide acceptable operations.

The costs of the improvements to the west would be excessive. Excluding right-of-way acquisitions, constructing an eight lane section starting west of Bywater Road transitioning to six lanes at Spa Road would be \$2,279,000, assuming a full curb and gutter section with eleven foot lanes. The improvements at Hillsmere Drive would cost approximately \$10,000, excluding right-of-way.



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The intersection assessments using a low one percent growth rate without site specific development along Forest Drive and current proposed improvements would still be below acceptable thresholds, as shown in Table 11 and Figure 9.

TABLE 11
LEVEL OF SERVICE SUMMARY
DESIGN YEAR 2010 - LOW GROWTH
NO ADDITIONAL DEVELOPMENT
FOREST DRIVE

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road	F	E
Bywater Road	E	F
Hilltop Lane	F	D
Spa Road	E	D
Hillsmere Drive	D	D
Edgewood Road	B	A
Arundel on the Bay	A	A

Review of the analyses indicates that even with a low growth rate and no additional development within the peninsula, additional roadway improvements would be required between Chinquapin Round Road and Spa Road.

As expected, adding the projected traffic from development within the corridor considerably worsens intersection operations. Table 12 provides a summary of the levels of service with the currently proposed lane geometry. Levels of service, project volumes and volume-to-capacity ratios are illustrated in Figure 10 for the low growth/full build-out scenario. Major improvements would be required along Forest Drive to accommodate projected traffic. Figure 11 and Table 12 summarize the improved levels of service that can be expected with additional roadway improvements. Also illustrated in Figure 11 are the required roadway improvements to provide acceptable intersection operations.





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TABLE 12
LEVEL OF SERVICE SUMMARY
DESIGN YEAR 2010 - LOW GROWTH
FULL BUILD-OUT
FOREST DRIVE

Intersection Forest Drive at	Level of Service	
	A.M. Peak	P.M. Peak
South River Road	A	A
Chinquapin Round Road*	F/E	F/D
Bywater Road*	F/D	F/D
Hilltop Lane*	F/E	D/B
Spa Road*	F/C	F/B
Hillsmere Drive*	E/C	D/D
Edgewood Road	B	A
Arundel on the Bay	B	A

* LOS with current proposed geometry/LOS with additional roadway improvements

As shown, trip reduction or diversions would be required between Bywater Road and Hilltop Lane. Roadway improvements alone cannot accommodate projected traffic.

4. Design Year 2010 Roadway Segment Operations

The applicable mid-block sections of Forest Drive were reassessed with both scenarios of the design year 2010 traffic volume and existing lanes. As with the existing conditions assessment, the analyses were conducted using the 1995 HCM. Computation sheets are provided in Appendix D; results of the analyses are summarized below in Tables 13 and 14.



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TABLE 13
LEVEL OF SERVICE SUMMARY
FOREST DRIVE - MID BLOCK SEGMENTS
2010 - HIGH GROWTH SCENARIO

Forest Drive To/From	A.M. Peak Hour		P.M. Peak Hour	
	EB	WB	EB	WB
Link Road to/from Dominoe Road	A	A	A	A
Tyler Avenue to/from Hillsmere Drive	B	B	C	A
Hillsmere Drive to/from Edgewood Road	B	B	C	A
Edgewood Road to/from Arundel on the Bay	A	B	A	A

TABLE 14
LEVEL OF SERVICE SUMMARY
FOREST DRIVE - MID BLOCK SEGMENTS
2010 - LOW GROWTH SCENARIO

Forest Drive To/From	A.M. Peak Hour		P.M. Peak Hour	
	EB	WB	EB	WB
Link Road to/from Dominoe Road	A	A	A	A
Tyler Avenue to/from Hillsmere Drive	B	B	C	A
Hillsmere Drive to/from Edgewood Road	B	B	C	A
Edgewood Road to/from Arundel on the Bay	A	B	A	A

Review of the table indicates that adequate mid-block capacity would be available.

D. SUMMARY

Forest Drive must serve the transportation needs of those who live, work, and play in the Annapolis Neck Peninsula. Current congestion will be exacerbated by the growth in background traffic and trips generated by localized development, despite an aggressive roadway improvement program planned by the State, County, and local developers. In order to ensure the continued vitality of the peninsula, comprehensive trip reduction or diversion measures must be considered for the Forest Drive Corridor. A relief route paralleling Forest Drive in the critical section from Chinquapin Round Road to Spa Road would be a viable option. The route would remove traffic from Forest Drive, improve



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incident management by providing an alternate route to Forest Drive, and facilitate the linking of communities.

II. ORIGIN-DESTINATION STUDY

A. INTRODUCTION

An origin-destination (O-D) study was performed as part of the Forest Drive corridor study that was conducted by Whitney, Bailey, Cox & Magnani (WBCM). Forest Drive is a congested arterial that provides access from multiple suburban residential neighborhoods in Annapolis to US 50 and other major thoroughfares. The information gathered from the turning movement counts proves the high level of congestion on Forest Drive. As part of the planning analyses, the City of Annapolis instructed WBCM to perform an O-D study. An O-D study of Forest Drive provides information of where vehicles are coming from, where they are going and supplemental information such as trip purpose and the use of transit. There are multiple types of O-D studies. The most common O-D techniques employed are:

- License-plate studies
- Roadside-interview studies
- Coded card studies
- Mail-Back Questionnaires

A license plate study requires the recording of license plates numbers before vehicles enter the study area (or arterial in this case), and after the vehicles have left the study area. For a study location such as the Forest Drive arterial, a large number of recorders would be necessary to record vehicles entering and exiting all access points to and from Forest Drive. The results of the license-plate studies just give vehicle origin and destination information.

Coded card studies are similar to license-plate studies. However, instead of recording plate numbers, coded index cards are given to motorists at the entrance points to the study area, and returned at the exit points. Disadvantages to each of the techniques are that no information is gathered regarding trip purpose, en route stops, trip frequency, etc.

Roadside-interview studies are have several negative attributes. These type of studies require motorists to pull off the road and answer multiple questions concerning their trip





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origin and destination. During peak travel times, motorists are often unwilling to stop their commute to answer questions.

The City of Annapolis and WBCM decided that a mail-back questionnaire would be the most efficient type of O-D study. It requires short questionnaires to be disseminated to motorists at normal stopping points, such as traffic signals. U.S. postage is affixed to the questionnaires prior to dissemination, so that motorists can fill the survey out at their leisure and return it post-paid. Not only will information such as trip origin and destination be gathered from this survey, but also information such as intermediate stops and public transit preferences can be gathered. An average of 5-15% return rate can be expected from a mail-back questionnaire.

One alternative to the mail-back questionnaire is a mass area wide mailing of questionnaires. This would reduce the need for surveyors to physically give the survey to individual motorists. However, the mail return rate is much lower because a larger number of people to which this survey does not apply receive the survey. Since the City of Annapolis just wanted information concerning traffic on Forest Drive, it was decided to perform a mail-back questionnaire, where the surveys were physically handed out to motorists at signalized intersections.

B. SURVEY FORM DESIGN

The wording and visual presentation of an O-D survey is very important. Survey questions need to be clearly written so that confusion is kept to a minimum. The survey form should not be too long. One page of questions is sufficient. Survey return rates are drastically reduced when individuals are required to fill out multiple pages of questions. The survey that was designed by WBCM and the City contained questions geared towards trip origin, intermediate stops, trip destination, use of public transit, and home address. Spaces were also provided for comments and suggestions. Figure 12 contains the survey form.

C. SURVEY DISTRIBUTION

Employees from both the City of Annapolis and WBCM distributed survey forms at five locations on Wednesday, April 3rd, 1996. Table 15 contains the distribution time periods and locations. Each of the survey distribution intersections is signalized, and the distributors were instructed to hand out survey forms during the signal red phase for the specified approach. Several of the larger intersections required multiple distributors,





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while the smaller intersections were handled by one distributor. A total of 5463 survey forms were distributed.

FOREST DRIVE ORIGIN-DESTINATION STUDY

As part of an effort to improve traffic flow along Forest Drive, the City of Annapolis is conducting a study of trip origins and destinations. We need your help! Please complete this brief questionnaire, trifold at the arrowheads, and mail postage paid to the address on the back by next Monday.

SURVEY LOCATION: _____

☐ A.M. ☐ Mid ☐ P.M.

Please indicate the primary purpose of this trip:

- | | |
|---|--|
| <input type="checkbox"/> Commuting to/from Work | <input type="checkbox"/> Shopping |
| <input type="checkbox"/> Commuting to/from School | <input type="checkbox"/> Business Travel |
| <input type="checkbox"/> Other _____ | |

The following questions relate to stops you made on this trip one way.

- Where did your trip originate? Street Name: _____
Nearest Intersection: _____ Zip Code: _____
- What was your final destination? Street Name: _____
Nearest Intersection: _____ Zip Code: _____
- Did you make any stops in between? If yes, where?
Stop 1: Street Name: _____ Zip Code: _____
Nearest Intersection: _____
Stop 2: Street Name: _____ Zip Code: _____
Nearest Intersection: _____

Does this trip include use of public transit? If so, please note type: _____

What local public transit improvements would you support? _____

Where do you live? Community: _____ Zip Code: _____

Nearest intersection: _____

How often do you travel Forest Drive? (Please answer only one)

____ times per day ____ times per week ____ times per month ____ times per year

Would you use park-n-ride lots if provided in the Forest Drive corridor? ____ Yes ____ No

Comments: _____

THANK YOU FOR YOUR ASSISTANCE!

Figure 12: Origin-Destination Survey Form





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TABLE 15
SURVEY DISTRIBUTION TIMES AND LOCATIONS

7:30 - 9:30 AM	10:30 AM - 12:30 PM	3:30 - 5:30 PM
Forest Drive @ South River Road	Forest Drive @ South River Road	Forest Drive @ South River Road
Forest Drive @ Newtowne Drive	Forest Drive @ Newtowne Drive	Forest Drive @ Newtowne Drive
Northbound Spa Road @ Hilltop Lane	Northbound Spa Road @ Hilltop Lane	Southbound Spa Road @ Forest Drive
Northbound Bay Ridge Road @ Tyler Avenue	Southbound Bay Ridge Road @ Forest Drive	Southbound Bay Ridge Road @ Forest Drive
Westbound Forest Drive @ Hillsmere Drive	Eastbound and Westbound Forest Drive @ Hillsmere Drive	Eastbound Forest Drive @ Hillsmere Drive

D. DATA ANALYSIS

The WBCM address was printed on the survey forms as the return address. Survey forms began arriving at WBCM the next day after the distribution. A total of 2041 forms were returned (61 of which were not included in the following analyses due to late arrival), giving a return rate of 37.4%; well above the average expected return rate. The data was entered into a spreadsheet database program. The survey data was sorted to highlight specific travel patterns. Appendix A contains the survey database output for all five locations. Tables 16 through 21 summarize the returned survey data.

TABLE 16
NUMBER OF RETURNED SURVEYS BY TIME OF DAY

	AM	MID	PM	Unknown	TOTAL
Newtowne	339	113	193	71	716
Hillsmere	255	125	134	3	517
South River	25	39	11	6	81
Spa	193	59	62	51	365
Bay Ridge	165	63	70	3	301
TOTAL	977	399	470	134	1980

TABLE 17
TRIP PURPOSE BY TIME OF DAY (%)

	AM					MID					PM				
	1	2	3	4	O	1	2	3	4	O	1	2	3	4	O
Newtowne	77.3	5.3	3.2	3.8	10.4	27.4	4.4	25.7	16.8	25.7	54.4	3.6	10.9	7.3	23.8
Hillsmere	76.9	5.5	2.3	2.0	13.3	24.8	6.4	22.4	15.2	31.2	62.7	3.0	12.7	5.9	15.7
South River	52.0	4.0	12.0	12.0	20.0	15.4	0	53.8	10.3	20.5	54.5	0	0	18.2	27.3
Spa	70.5	9.8	3.1	1.0	15.6	20.3	10.2	13.6	15.3	40.6	43.5	4.8	9.7	8.1	33.9
Bay Ridge	71.5	13.3	4.2	3.0	8.0	15.9	3.2	42.9	9.5	28.5	54.3	1.4	18.6	1.4	24.3

1. Commuting to/from Work
2. Commuting to/from School
3. Shopping
4. Business Travel
- O. Other



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TABLE 18
% TRIPS WITH ORIGIN OR DESTINATION IN FOREST DRIVE VICINITY
(FOREST DRIVE VICINITY ZIP CODES: 21401, 21403)

	Origin			Destination		
	21401	21403	Other	21401	21403	Other
Newtowne	22.6	37.7	39.7	15.9	59.2	24.9
Hillsmere	22.2	29.4	48.4	9.7	69.8	20.5
South River	46.9	11.1	42.0	42.0	22.2	35.8
Spa	13.7	69.6	16.7	41.9	23.6	34.5
Bay Ridge	8.9	81.1	10.0	28.9	47.5	23.6

TABLE 19
% LOCAL TRIPS

	From 21401 to 21401	From 21401 to 21403	From 21403 to 21401	From 21403 to 21403	Total Internal Trips (#, %)
Newtowne	3.9	8.9	15.7	14.2	306 - 42.7%
Hillsmere	1.2	7.0	20.3	11.0	204 - 39.5%
South River	27.2	3.7	8.6	4.9	36 - 44.4%
Spa	4.1	6.6	37.5	9.6	211 - 57.8%
Bay Ridge	3.0	5.3	25.2	36.5	211 - 70.0%
Total	4.0	7.2	22.1	15.6	968 - 48.9%





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TABLE 20
% OF INTERMEDIATE STOPS

	AM	MID	PM
Newtowne	17.7	42.5	25.9
Hillsmere	21.2	40.0	33.6
South River	24.0	25.6	45.5
Spa	29.0	30.5	41.9
Bay Ridge	32.1	46.0	40.0

TABLE 21
% TRANSIT TRIPS

	Trips that included Public Transit (# - %)	Motorists that would use Park and Ride lots on Forest Drive (# - %)
Newtowne	15 - 2.1%	78 - 10.9%
Hillsmere	3 - 0.01%	58 - 11.2%
South River	2 - 2.5%	8 - 9.9%
Spa	9 - 2.5%	33 - 9.0%
Bay Ridge	2 - 0.01%	28 - 9.3%





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E. CONCLUSIONS

The following general points can be made concerning the travel patterns along Forest Drive:

- The high 37.4% return rate shows the high commuter interest in the congestion situation on Forest Drive.
- School traffic is not a major element of the peak period trips; less than 6% of the traffic was school oriented. Spa Road and Bay Ridge Road serve schools; however, the school-related trips accounted for only 13% of the total trips.
- Commuting trips accounted for the majority of the traffic even during the mid-day.
- Shopping trips are not a major component of the morning and evening trips. Mid-day shopping trips are only significant along Bay Ridge Road heading towards the retail centers along Hillsmere Drive. Shopping trips comprised the majority of trips along South River Road during the mid-day period indicating that "Old" Forest Drive is still perceived as a viable alternative route to Aris T. Allen.
- Roughly 49% of the traffic is internal to the peninsula and could be served by a local transit system. Sixteen percent of the total traffic has origins and destinations east of Spa Road.
- Thirty three percent of the traffic had origins or destinations within the peninsula passing through Forest Drive west of Spa Road. An Alternative route south of Spa Road would be a viable option for the local trips.
- A high percentage (72.8%) of the traffic passing through the Forest Drive/South River Road intersection is through traffic, not originating or destined for the 21401 zip code.
- The traffic to and from areas east of Spa Road include a significant number of intermediate stops with percentages over 40%.
- Newtowne Drive traffic is destination specific with minimal intermediate stops.





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- Mid-day traffic includes multiple stops. Such a travel pattern could be supported by a local shuttle bus system.
- Transit is not popular with residents of the peninsula. A maximum of only 2.5% of the respondents included transit as part of their trips. Park-n-Rides, if available would only attract a maximum of 11% of the drivers.

III. CONCEPT DEVELOPMENT FOREST DRIVE RELIEF ROUTE

A. INTRODUCTION

The results of our traffic studies indicate that existing Forest Drive west of Spa Road can not be sufficiently improved to accommodate traffic levels associated with ultimate build-out of the Annapolis Neck Peninsula. The only practical solution is a new parallel "relief route" that will serve the large undeveloped tracts of land south of Forest Drive. However, this road is not intended to be a bypass designed to move large volumes of traffic at high speeds, while bisecting the community. Rather, it will be developed as a local facility designed primarily to enhance movement within the community. It will provide the missing redundancy in the roadway system, allowing motorists and emergency services to tailor their route to their destination. Prior to initiating development of relief route concepts, our planning team established the primary design goals. Then, through numerous field views, our engineering and environmental staff became familiar with the corridor's natural and man-made environment, highlighting issues and constraints to be considered throughout the project development process. The following sections discuss the project goals, the primary project issues/constraints, the concepts considered and the preliminary design for the recommended alignment.

B. PRIMARY DESIGN GOALS

Project Termini - Aris T. Allen Blvd. to east of Spa Road - The portion of Forest Drive which currently experiences, and will continue to experience, the greatest level of congestion is that which includes the Chinquapin Round Road, Bywater Road, Hilltop Lane and Spa Road intersections. To provide satisfactory relief, the western terminus of the new facility should be Aris T. Allen Boulevard (MD 665), approximately midway between MD 2 and Chinquapin Round Road, while the eastern terminus should be at a point east of Spa Road. A additional point of access to Forest Drive is also desirable in the vicinity of Hilltop Lane or South Cherry Grove Road.





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Local Street - The new facility will be classified as a Residential Arterial. The posted speed limit will be 35 mph, with a design speed of 45 mph.

Access Control - Points of access will be limited to major intersections and entrances to subdivisions. No residential or commercial driveways will be allowed.

Typical Section - The four lane section will have a raised, landscaped median to create a parkway-like design. Slopes will be acquired in fee simple to allow additional area for plantings. The two lane section will be identical, minus the median. See Figure 13.

Both the four lane and two lane sections will include a sidewalk on one side and a bike path on the other. Lighting will be low mast style, in keeping with the parkway design, to minimize light intrusion on adjacent properties.

Public Services - The design will pay special attention to accommodating emergency services, trash collection and school bus routes.

Multi-Modal Opportunities - The design will also provide for joint use by public transit, pedestrians and bicyclists.

Community Linkages - The many cul-de-sac roadways off of Forest Drive make it difficult to move within the community, not just for vehicles but also for pedestrians and bicyclists. The design will consider opportunities for providing additional linkages between communities.

The Natural Environment - The design will be sensitive to the natural environment including floodplains, streams, wetlands, the Chesapeake Bay Critical Area, terrestrial and aquatic habitat, forest stands, etc.

The Man-Made Environment - The design will be sensitive to zoning, comprehensive plans, improved parcels, proposed development plans, major utilities, etc.

Advance Warning - Motorists approaching the MD 2/Aris T. Allen Boulevard interchange from the west must be provided ample information on the upcoming change in roadway character from a freeway to that of a local boulevard serving as a gateway to Annapolis.





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C. ISSUES AND CONSTRAINTS

Roadway Design Criteria - For a design speed of 45 mph and a maximum superelevation rate of .04, the minimum radius of horizontal curvature is 450 feet. The minimum grade along the roadway centerline to promote positive drainage is 0.5% and a desirable maximum for level terrain is 2.0 to 3.0%.

Property Patterns - Property lines for each subdivision and individual parcel were taken from A.A. County and City of Annapolis tax maps. Attention will be given to minimizing property impacts (i.e. - severing access, odd shaped residual parcels, etc.).

Residential Development - Existing development patterns, in conjunction with proposed or approved subdivisions, were used to establish a general boundary outside of which the relief route concepts were generated. In certain instances, the relief route alignment might follow or modify a proposed subdivision alignment.

Local Business - Most businesses are concentrated along Forest Drive.

Educational Facilities - There is one public school within the immediate area. Annapolis Middle School is situated in the triangle formed by Spa Road and Forest/Old Forest Drive.

Parkland/Recreational Facilities - Quiet Waters Park lies between Annapolis Neck Road and South River, just west of Hillsmere Drive. There are also tennis courts and rec facilities associated with the Annapolis Middle School.

Soloman's Island Road (MD Route 2) Interchange - Immediately west of Church Creek, this partial cloverleaf (arranged as a diagonally opposite dual quadrant) with Aris T. Allen Boulevard is the last interchange motorists encounter before entering the Annapolis Neck community. Siting of the relief route intersection with Aris T. Allen Boulevard must be sensitive to the distance from the MD 2 Interchange, especially the west to north ramp and the associated weaving movements.

SHA Stormwater Management Facility - Construction of Aris T. Allen Boulevard included a SWM pond on the south side of the roadway, just inside the City of Annapolis.





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Streams - Forest Drive generally is a ridge road and as such does not have stream crossings. The only place within the relief route study area that has stream related topography is at the headwaters of Church Creek.

Wetlands - Only a few wetlands of significance were found within the study area. One is associated with the small tributaries of Church Creek. Another lies along the short dogleg section of Crystal Farm Road.

Forest Stands - There is only one major forest stand within the study area. It surrounds the headwater tributaries of Church Creek.

D. CONCEPT DEVELOPMENT

A wide variety of alignments were initially developed. Several held close to the current development envelope, while others were closer to South River. At the western end, numerous connections to Aris T. Allen Boulevard were evaluated. Potential connections to Forest Drive were explored at South Cherry Grove Road, Hilltop Lane, Gemini Drive, and Tyler Avenue. Each option was subjected to a cursory screening for major impacts and potential fatal flaws. The leading candidate alignment was then refined based on results of a field walk by members of our engineering and environmental staff and is illustrated in Figure 14. A profile was then generated to ensure that grades could meet the general design criteria, that slope limits could be estimated in critical areas and that a rough waterway opening could be estimated for any stream crossing. The proposed profile is illustrated in Figure 15.

E. RECOMMENDED ALIGNMENT

Section One of the recommended relief route alignment begins at Aris T. Allen Boulevard immediately east of the State Highway Administration's Stormwater Management Facility. This tie point was selected to avoid the SWM pond, to provide maximum separation from the MD 2 interchange and to minimize impact to the forest area. The intersection will be designed to serve traffic to and from the west. As noted below in Section F, a free right turn can also be provided from the relief road to eastbound Aris T. Allen Boulevard. However, no provision will be made for westbound Aris T. Allen traffic to enter the relief route. To do so would greatly reduce the capacity of the intersection and because that movement will be available via Bywater Road.





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The alignment proceeds along the edge of Baytowne Village, slowly dropping in elevation to reduce visual intrusion, to reduce the amount of fill in the swales and to minimize the impact on the small headwater tributary of Church Creek. The alignment then swings eastward, crossing Bywater Road and Green Briar Lane, staying close to the current edge of development. The alignment then swings northeasterly, crosses Newtowne Drive and connects to Forest Drive directly opposite Hilltop Drive. Traffic projections indicate that this 6,700-foot section of roadway will require a 4-lane section. The typical section for Section One is shown on Figure 13.

Section Two of the recommended relief route alignment begins at Station 45+40 of Section One, curves behind the Newtowne community and the upland wetland before swinging east to meet Post Parade Drive in the proposed Steeplegate Subdivision. Just east of Steeplegate Drive, the relief route deviates from the proposed subdivision street in order to align with the Gemini Drive/Forest Drive intersection. Traffic projections indicate that only two lanes are required for Section Two, except the segment between Forest Drive and Spa Road which might need to be wider to better accommodate school traffic.

As discussed under *Primary Design Goals*, the planning team was to look for opportunities for improving vehicular, pedestrian and bicycle linkages within the study area. To complement access provided by the relief route, we recommend two additional roadways be constructed. The first is a two lane local roadway built to connect South Cherry Grove Road, the relief route and Steeplegate Drive. The second is a two lane extension of Steeplegate to the east behind the Annapolis Middle School to meet Forest Drive opposite Tyler Avenue.

F. TRAFFIC ANALYSES

A preliminary assessment of impacts to traffic operations was conducted assuming the relief route in place. The alignment used in the analyses included access to Forest Drive from Gemini Drive and Hilltop Lane. Traffic volumes considered in the analyses were the year 2010 Low Growth, Full Build-out volumes. Trips were diverted to the relief route from development (existing and proposed) between Bywater Road and Spa Road as well as through traffic with origins/destinations east of Gemini Drive. Attractions of





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traffic to/from the east from major intersecting streets along Forest Drive to the relief route were as follows:

Chinquapin Round Road	0%
Bywater Road	60%
Hilltop Lane	25%
Spa Road	40%

The residual trips were discounted from through traffic along Forest Drive east of Gemini Drive. As noted in the origin-destination study, the majority of the traffic demand is to/from Aris T. Allen Boulevard west of Chinquapin Round Road. Therefore, the limiting factor in trip diversion to the relief route is the capacity at the Aris T. Allen Boulevard/Relieve Route intersection, not demand along the relief route.

The intersection of the relief route and Aris T. Allen Boulevard can be designed in one of two ways. One option is to signalize the intersection and provide a double or triple left-turn exiting the relief route, thus accommodating the heavy outbound traffic flow during the morning peak hours. The signal would stop traffic in both directions on Aris T. Allen Boulevard, thus improvements would be required on the westbound approach to provide additional lanes in order that the resultant queues from the heavy outbound flows are accommodated.

A second option would provide a partial traffic signal that would stop eastbound traffic, left-turn traffic from the relief route would merge with the westbound flow. Westbound traffic would not stop. A disadvantage of the second option is that the left-turn volume capacity available from the relief route would be only a single lane. An additional disadvantage of the partial signal is that the weave from the relief route to the northbound MD 2 exit would be less than ideal.

A traffic count was conducted during the morning peak period to quantify the number of vehicles traveling along westbound Aris T. Allen Boulevard that exit at MD 2 north. The count data is provided in Appendix F, and indicates only a 16% attraction to the exit ramp. Applying the percentage to the projected relief route and Aris T. Allen Boulevard traffic indicates that the weave from the relief route to the exit ramp during the critical morning peak hour would operate at just into an unacceptable range. The computation sheets are provided in Appendix F. The actual operations would be improved since communities would, for convenience, stay on Forest Drive if their normal commute would include MD 2 northbound, and not use the relief route. Sufficient residual demand



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would exist for the relief route to replace the MD 2-bound traffic that would not divert to the relief route.

The relief route would reduce through volumes along Forest Drive between Chinquapin Round Road and Spa Road. Figure 16 indicates the design year 2010 lane geometry, assuming the SHA/County/Developer sponsored improvements, in addition to a double left northbound on Hillsmere Drive, are implemented along with the corresponding levels of service with diversion to the relief route considered. As shown, although capacity deficiencies still exist along the Bywater Road to Spa Road section of Forest Drive, the magnitude of the "failure" is much less than without the relief route (Figure 11).

The magnitude of additional improvements to provide acceptable operations at all intersections is reduced with the relief route as shown in Figure 17. Projected design year 2010 traffic volumes could be accommodated with minimal improvements.

G. CONCLUSION

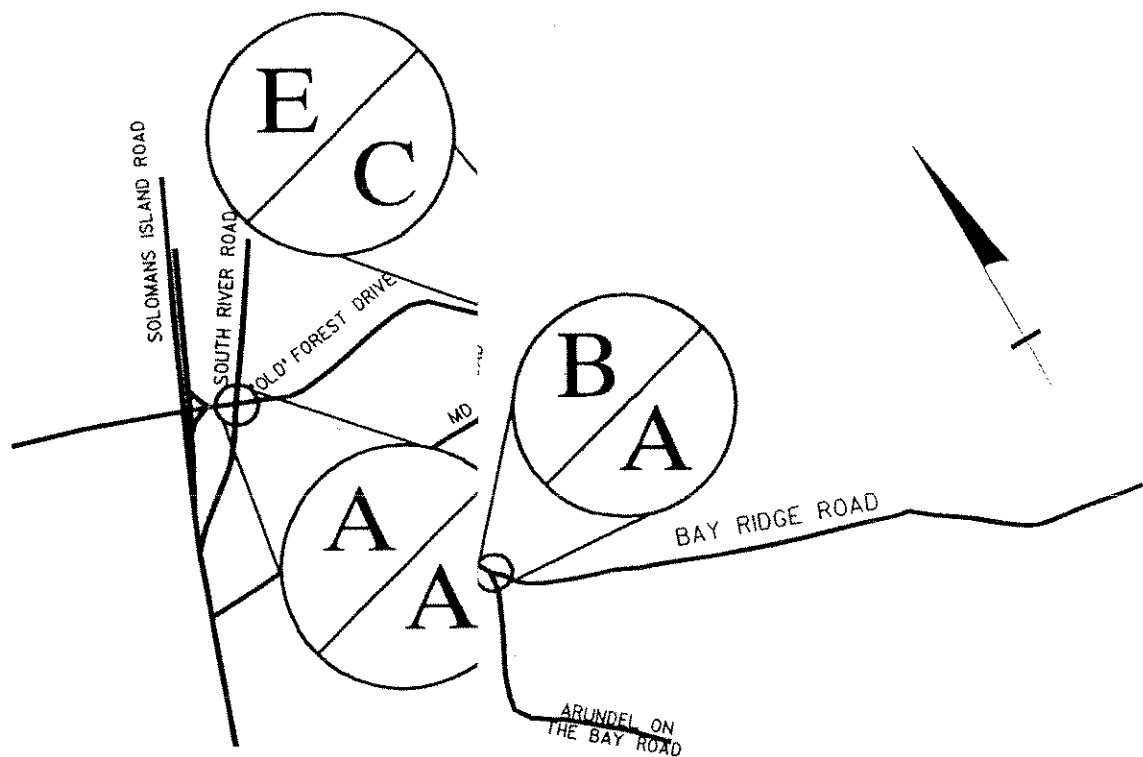
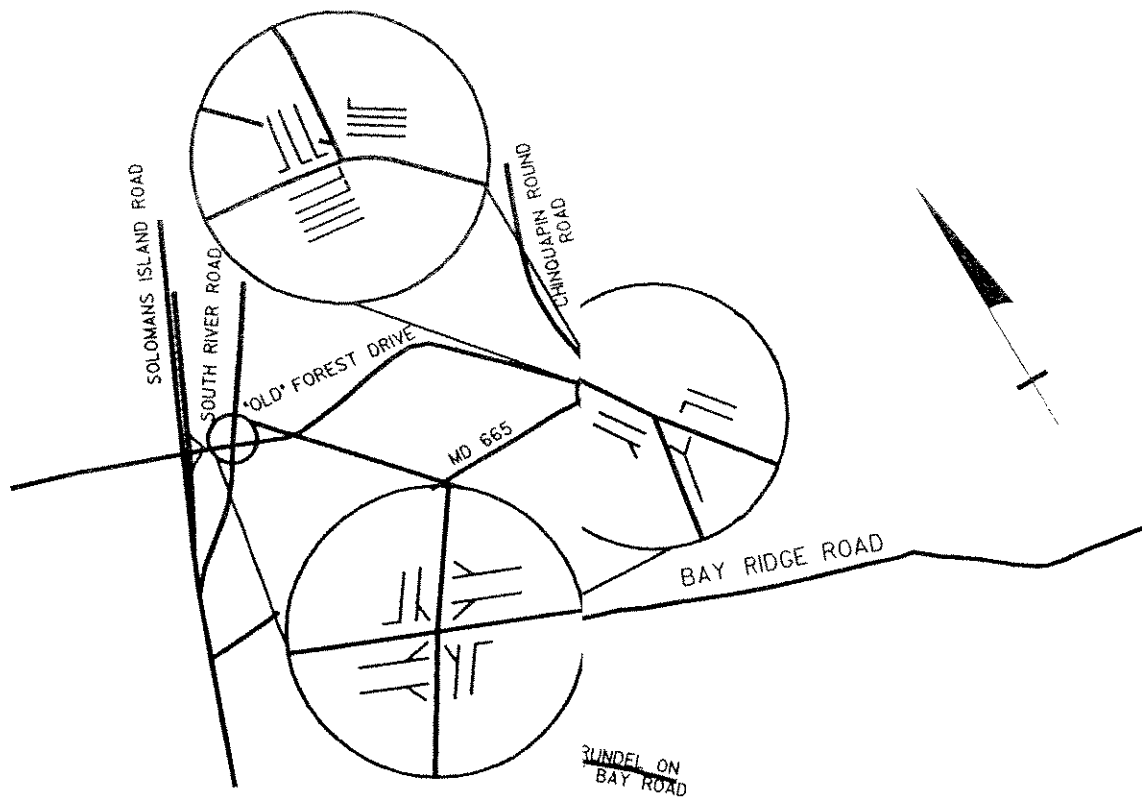
The relief route concept, as recommended, is the culmination of a comprehensive multi-discipline planning effort by an experienced team of urban planners, traffic and highway engineers, and environmental specialists. It fully satisfies the primary design goals while being sensitive to the many issues and constraints within the study area. Following final review and approval by the City of Annapolis, Anne Arundel County and the State Highway Administration, the relief route concept will be incorporated into the both the City and County Master Plans, serving to guide future development in that portion of the Annapolis Neck Peninsula.

IV. SUMMARY AND CONCLUSIONS

The Forest Drive corridor is currently experiencing excessive traffic demand for the available roadway capacity. The major area of poor levels of service is Forest Drive between Chinquapin Round Road and Spa Road. Even with major roadway improvements, projected traffic demands cannot be accommodated. Development within the corridor will exacerbate the current situation. The roadway congestion contributes to the accident experience along the corridor within the critical section. Chinquapin Round Road to Spa Road. Table 22 provides a summary of the levels of service with various scenarios within the critical Chinquapin Round Road to Spa Road section. Results of the origin-destination study reveal that Forest Drive is used as a through route with minimal internal trips during the peak hours. Transit usage was not popular with motorists based on survey results.

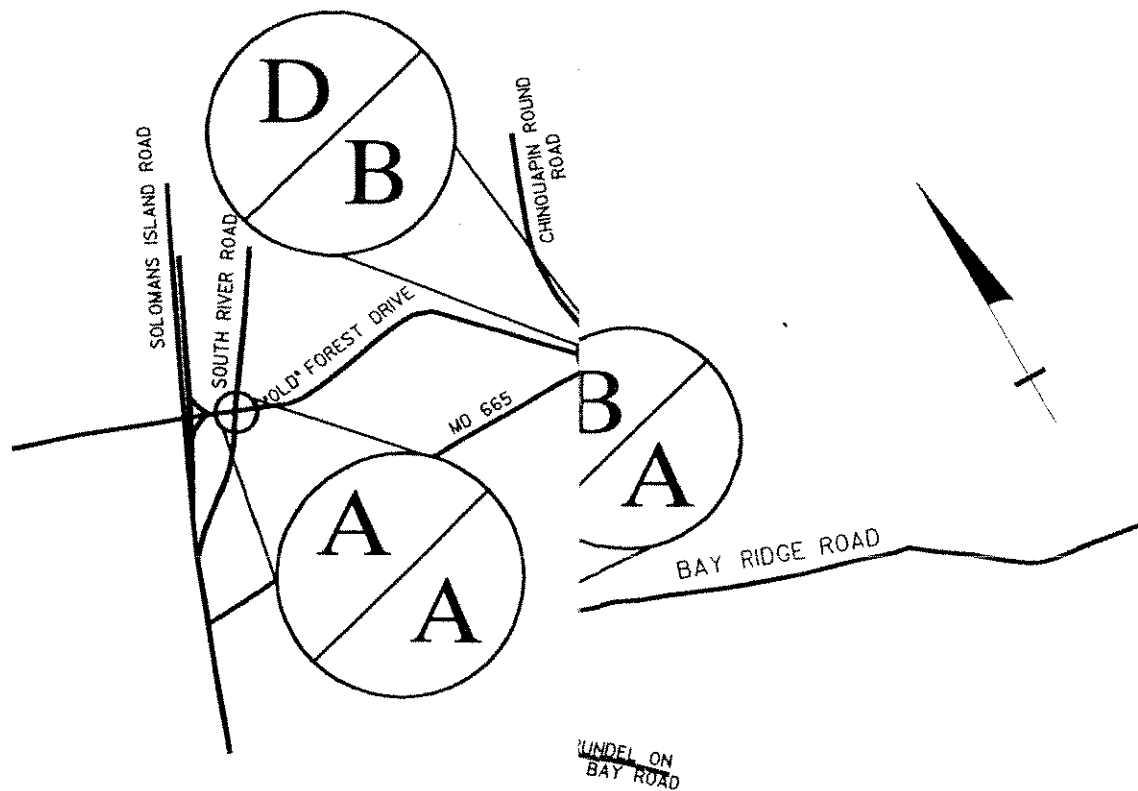
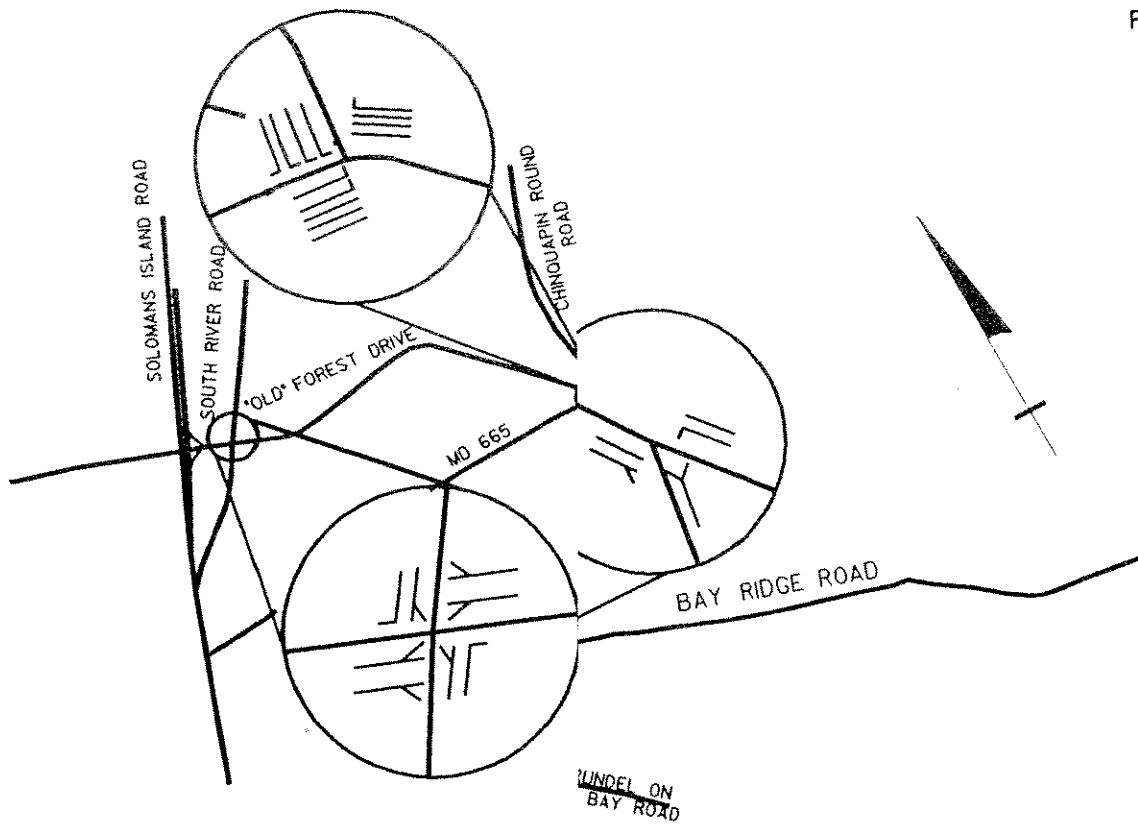


FIGURE 16



*FOREST DRIVE
2010 LANE GEOMETRY &
LEVELS OF SERVICE
LOW GROWTH W/RELIEF*

FIGURE 17



FOREST DRIVE
2010 NECESSARY IMPROVEMENTS
AND LEVELS OF SERVICE
LOW GROWTH W/RELIEF



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In an effort to address anticipated traffic demands and to provide the required network redundancy, a relief route for Forest Drive is recommended. The route would parallel the critical section of Forest Drive from west of Chinquapin Round Road to east of Spa Road. The route would not be a high-speed facility and would facilitate pedestrian access to communities while minimizing environmental impacts.

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